canusa

Newsletter

Canada
United States
Spruce Budworms
Program

NUMBER 18, SEPTEMBER 1981

Spraying For The Spruce Budworm In Quebec

Chemical control for spruce budworm is a fact of life in Canada and the United States, and when the Quebec Department of Energy and Resources invited me to visit its spraying operations in Riviere-du-Loup, I jumped at the chance to explore this highly controversial subject firsthand. The second week in June, I joined Chuck Buckner's assistant, Bob Taylor, and Janet Lalonde of the Canadian Forestry Service's editorial staff, in Quebec City. Louis Dorais and Jean-Guy Davidson, our hosts, flew us up to the operational base at Riviere-du-Loup, a small town 193 km (120 miles) northeast on the St. Lawrence River. We landed in a light drizzle and waited for the rain to stop so spraying could begin.

It rained for 2 more days, and I never did get to follow the spray plane. But this enforced suspension gave me all the more time to talk with Louis Dorais about safety in handling pesticides. I was impressed with what I learned.

The Quebec spraying program will treat about 769 000 ha (1.9 million acres) of budworm-infested forest land in 1981 — roughly 30 350 ha (75 000 acres) of this with *Bacillus thuringiensis* (B.t.) and the remainder with aminocarb (Matacil®) and fenitrothion (Sumithion®). B.t. is used where infestations are within 2 km (1.24 miles) of human habitation or situated near lakes. Because aminocarb is cheaper this year than fenitrothion, it is used over 80 percent of the program. But both chemicals are considered to give equally good results. There's no question that if B.t. were not four times as costly as chemicals, it would be used much more widely. Economics will be discussed again, later.

The Quebec team sprays to ensure present and future wood supplies to forest industries, once budworm-caused defoliation has begun. The official goal is to repeat the procedure as long as the infestation lasts, reduce the stress on white spruce/balsam fir, accelerate the collapse of the infestation, and stabilize tree mortality. The territory covered included spray blocks in the lower St. Lawrence Valley and on the Gaspe Peninsula to the North Shore area. First spray application coincides with bud flare and the fourth larval instar; second application follows about 5 days later, weather and wind conditions permitting.

In all, the Quebec operation uses five 4-engine planes, three based in Riviere-du-Loup and two at Bonaventure in the Gaspe. One plane is reserved for B.t. only. Flying such big planes (Constellations and DC-4's) at 320 km/h (200 mph) and a mere 90 m (300 ft) above the canopy is no easy task. Each of the planes carries three people and two 5680-L (1500-gal) tanks (enough to spray for 16 minutes). A control pilot follows in a chase plane while a field crew performs biological evaluations on the ground during and after the mission.

These evaluations are part of the accountability that characterizes Quebec's program. A five-member team of biologists follows the spray plane, checking populations of nontarget organisms (aquatic and terrestrial insects and pollinators), and collecting samples of foliage, soil, and water to trace the insecticide dispersal. Chemical analysis carried out later can detect amounts of 1 to 5 p/m in foliage and 1 to 20 p/m in water. Before spraying, field crews leave white paper squares on roadsides to monitor evenness of application and droplet size, both of which affect the efficiency of spray operations. For chemical insecticides, the goal is 10 to 15 droplets/cm^2, each with a diameter between 70 and 100 microns. Petri dishes left to sample for B.t. should reveal deposits of 20 to 24 colonies/cm^2. Adjusting the spray nozzles to yield results this accurate is an art in itself.

Weather conditions determine if the spraying can take place, so every 15 minutes the system records temperature and wind speed. Under ideal conditions, the wind is less than 12 km/h (8 mph) and the ground is cool (to avoid radiation of heat and consequent updrafts that would prevent droplet dispersal).

The Quebec spraying personnel recognize that their insecticide formulations are extremely toxic, and they treat all aspects of the program with respect. Mixing of insecticides takes place only at Riviere-du-Loup. Louis Dorais showed us the big steel storage tanks that form a completely enclosed system, connected to water tanks and mixing tanks by pipes and valves. The tanks are located on a flat area covered with gravel, and the gravel has been pushed into hills 0.30 m (1 ft) high ringing the compound, to help contain leaks. An emergency shower is centrally located. The three or four most experienced personnel actually perform the mixing operations; other employees at the base camp do not come into contact with the concentrated insecticide. The insecticide (aminocarb) is mixed in the proportions of 35 percent insecticide and 65 percent 585 insecticide diluent. Once mixed, the insecticide passes through hydraulic pumps and hoses directly into the plane's holding tanks.

Speaking as Coordinator of Spray Programs, Louis told us that he had confidence in both chemical and biological controls for the budworm. But when insect populations exceed 35 larvae per 46-cm (18-in) branch, the chemicals perform better than B.t. It takes about 672 grams of B.t. solution to treat 1 hectare of forest (96 oz/ acre), but only 280 g (40 oz) of insecticides to cover the same area. Obviously, that's twice as much volume, so twice the airplane fuel, twice the airport usage, etc., are required to spray B.t. There's no gainsaying the economics operating here. Louis figures it

Figure 1. From the left, Louis Dorais and Michel Chabot show a box of budworm parasites to the author and Janet Lalonde. The ladies cast a baleful glance at the mounted specimens and were even less enthusiastic about handling live ones. On the wall map, push pins mark parasite collection stations in the St. Lawrence Valley and the Gaspe Peninsula.

costs at least four times as much to use B.t. as chemicals. Nevertheless, the Province of Quebec is strict about using only biological controls in areas of human habitation or surface water.

One ray of hope on the economic front is a series of experiments now being run on a much more concentrated form of B.t. (Novabac® 64B). If these trials are successful, the new formulation would permit the application of about 224 g/ha (32 oz/acre) instead of the present rate of nearly 672 g/ha (96 oz/acre). The cost reductions through lowering airplane fuel usage alone would make B.t. much more affordable.

Back at Louis's laboratory facilities in Quebec City, we were shown the program's documentation center, where Michel Auger explained the design of spray blocks and the extensive monitoring system used to record treatments. Every spray block is mapped and numbered, and on a big chart with push pins Michel's team keeps track of first and second treatments. Timing between treatments is important, but the weather doesn't always cooperate to allow exactly 5 days to elapse before the second spraying.

In another part of the Quebec laboratory, parasite/predator studies are going on, under the direction of Michel Chabot. He showed us specimen collections of dozens of spruce budworm parasites native to the Province of Quebec and estimated that at least 20 percent of budworms are parasitized.

Michel reached into his specimen jar for a test insect, especially for the benefit of Janet Lalonde and myself. Under the microscope the larva zipped from side to side across the dish. Michel had told us that parasitized specimens were more sluggish than healthy ones, and he was afraid that his sample insect was healthy in view of its speedy movements. But when he tore it apart with the picks, out popped a transparent larva of *Apanteles*. Michel was delighted, and so, to a lesser extent, were Janet and I. When Bob Taylor pointed out that its digestive system could be clearly seen lurching back and forth, I found that I knew more about *Apanteles* than I ever wanted to know.

Janet Searcy — Information Coordinator,
CANUSA Program
USDA Forest Service
Washington, D.C.

White Spruce Is Hot Stuff

In a side trip during my visit to Quebec, I spent one morning with members of Yvan Hardy's research team at Laval University. Robert Gagnon, first engineer, and Jean-Marie Binot, Ph.D. candidate, took me to their research plots on the Valcartier Experimental Forest 32 km (20 miles) outside Quebec City. Jean's study of temperature variation between paired white spruce and balsam fir trees suggests that spruce is a better host for the budworm because its microclimate can be much warmer than that of balsam fir.

In designing the study, Jean selected pairs of trees no more than 4.6-m (15-ft) apart, one of each species, and installed a sophisticated network of thermistors (temperature probes) in each tree (figure 2). Each probe is attached to a device on the ground, and a graduate assistant writes down the reading at each thermistor every hour between 6 a.m. and 8 p.m. (Previously research had established that temperatures were similar for both fir and spruce between 8 p.m. and 6 a.m., so those hourly readings were eliminated.)

Jean's data show that even for trees whose canopies are contiguous, the air temperature inside the crown of a white spruce is nearly always several degrees warmer than that inside the crown of a balsam fir. Differences as great as 5.6°C (10°F) are not uncommon!

Evidently this surprising variation is due to the fact that spruce, with its more numerous needles, offers a larger surface area than fir on which to receive solar radiation. Also, the denser crown of the spruce inhibits heat convection, a phenomenon more pronounced in balsam fir. In the paired trees, spruce budworms develop 4 to 5 days sooner in white spruce than in balsam fir.

Complete documentation of these experiments will appear in Jean's doctoral dissertation in 1982. Meantime, CANUSA researchers interested in this subject can read more about the work of Hardy's team (in French) in "Caractérisation des Zones d'Abondance de la Tordeuse des Bourgeons de l'Épinette," by Yvan Hardy and Robert Gagnon. Copies can be requested from the authors, Department of Forestry and Geodesy, University of Laval, Quebec.

Janet Searcy — Information Coordinator,
CANUSA Program
USDA Forest Service
Washington, D.C.

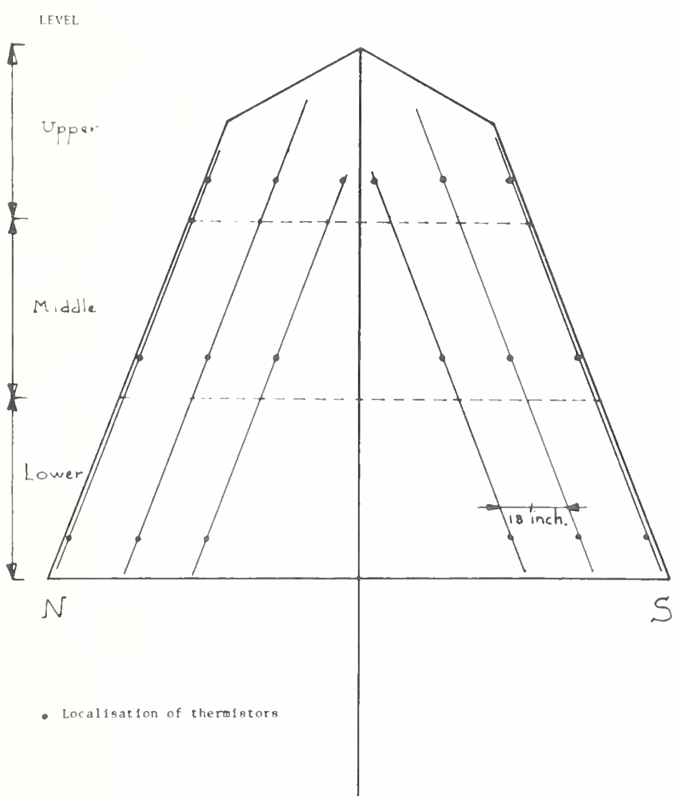

Figure 2. Disposition of thermistors in the crown.

Integrated Pest Management For Maine Forests

The Green Woods Project, a CANUSA demonstration project in Maine, demonstrates that some elements of an integrated pest management (IPM) system can be put into place now to better manage the spruce budworm problem. The available elements of IPM — forest management (including host management, spraying of chemicals or B.t., and no action), coupled with management analysis — can be combined effectively to reduce insecticide use and maintain forest productivity. We have adopted the terminology of "targeted harvesting" and "targeted spraying" to describe our approach.[1]

[1] See D. Gordon Mott. Spruce budworm protection management in Maine, Maine Forest Review 13, Summer 1980, for more complete background.

To test the system, we have entered into cooperative management with three forest landowners to establish demonstration areas where the system is being developed and applied. The cooperators are Great Northern Paper, an industrial landowner; the Seven Islands Land Co., a nonindustrial land-managing firm; and Baxter State Park, a public landowner.

One of the early questions addressed was how much of the spruce-fir forest required protection to sustain the goals of ownership if present harvest levels continue. A computer model, which incorporates the present age-class structure of the forest, separate growth and budworm-caused mortality functions for spruce and fir, and variable rates of harvesting and spraying, was devised to project the development of the spruce-fir resource to the year 2020. A preliminary application to

TOTAL INVENTORY
(2019 CUBIC FEET x 10^6 — 5.72 CUBIC METRES x 10^6)

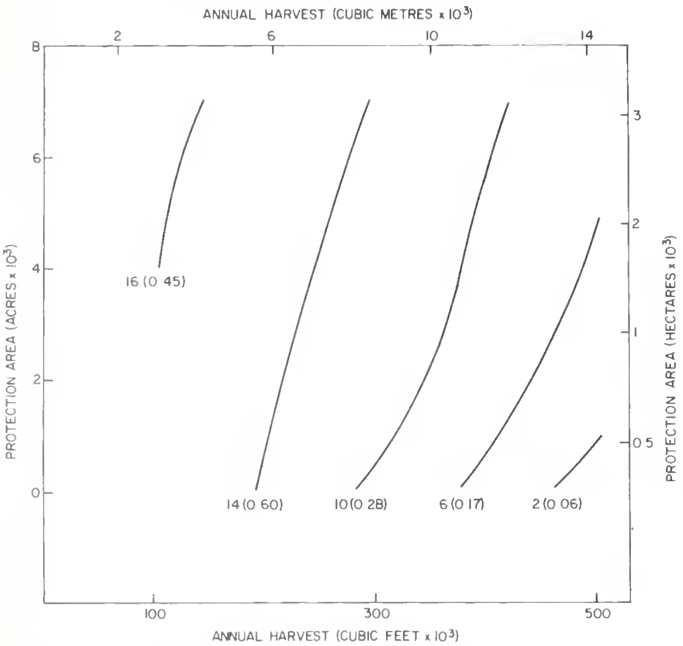

Figure 3. Response surface or "nomogram" used to analyze results of the management-analysis model. The contours show how the spruce-fir inventory 40 years from now will vary as a result of changes in the annual harvest level and the size of the area protected against damage by the spruce budworm.

the Statewide resource suggests that Maine lacks any significant surplus of spruce-fir. Considerable acreage near settlements, in aquatic buffers, and in voluntary withdrawals has already been eliminated from protection and is beginning to suffer heavy tree mortality. To avoid future shortages, we will have to protect most of the remainder until the mature fir is harvested during the next 20 to 30 years.

We have applied this model to develop integrated management plans for two of our demonstration areas. The model predicts how the spruce-fir inventory and many other attributes of the forest will vary as the area protected against the budworm and the annual harvest are changed (figure 3). Our cooperators have also applied the model to their entire ownerships, which total over 1.2 million ha (3 million acres) of spruce-fir forest in Maine.

After unneeded acreage, if any, is deleted permanently from protection, other opportunities exist to further reduce the need for protection. Through harvesting, stands can be converted from a relatively high to a relatively low vulnerability to budworm damage. And through better "targeting" of insecticide delivery, only the most vulnerable stands are sprayed as needed.

Vulnerability of softwood stands in Maine's spruce-fir types depends on the content of balsam fir, the most vulnerable host species. Red spruce and hemlock are considered to be moderately vulnerable and black spruce not very vulnerable. White spruce is an uncommon component of most stands.

Targeting of harvesting or spraying requires more definitive stand typing than has been customary, where the common designations have been simply softwood, mixedwood, etc. It is important to discriminate, within stands,the proportions of fir, spruce, hemlock when abundant, nonhosts such as cedar and pine; and within mixedwood stands, the amount of softwood, and whether this is largely fir or the less vulnerable hosts. Refined stand typing is available in several areas, including that of one of our cooperators, and is being developed in others. But overall, conventional forest typing is inadequate for determining the vulnerability of softwood stands. In the past, this fact has encouraged managers to treat all softwood stands in the same way. And, in general, mixedwood stands containing 6 or more cords to the acre (53.74 m^3/ha) of spruce-fir have been treated the same as softwood stands, even though vulnerability of mixedwood differs from that of pure spruce-fir, and protective treatment may be required less frequently.

Therefore, one of our first challenges was to obtain detailed stand data for our demonstration areas. Methodology has varied from the use of remote imagery, to intensive ground cruising, to a combination of the two.

Once the stand analysis is in hand, managers can select from several appropriate treatments with insecticides:

(1) Frequent chemical protection — mature softwood stands with 30 percent or more of the volume as balsam fir.

(2) Infrequent chemical protection — mixedwood with more than 6 cords per acre (53.74 m^3/ha) of spruce-fir, softwood stands with 70 percent or more of the volume as red spruce or other less vulnerable or nonvulnerable species, young softwood stands (less than 25 years of age).

(3) No chemical protection — hardwood stands, mixedwood with less than 6 cords per acre (53.74 m^3/ha) of spruce-fir, stands to be harvested within 3 years, black spruce stands, plus any isolated or unprotectable stands in the first two categories not essential to the future wood supply.

The rules above are general, not fixed, and must be adapted to the management objectives of region or ownership. Variations occur — for example, where stands soon to be harvested require treatment to ensure production of a seed crop for regeneration before the stands are harvested; where rapid growth must be maintained in young stands; or where the ownership contains little of the highly vulnerable forest type, and it can all be treated by harvesting.

Using these rules, managers have substantially reduced their dependence on chemical insecticides in the last 2 years. Spray map histories for 1975-81 for the St. Pamphile and Fifth St. John Pond demonstration areas show a reduction in acreage treated and a different type of spray blocking since 1979, when these principles were first applied (figure 4).

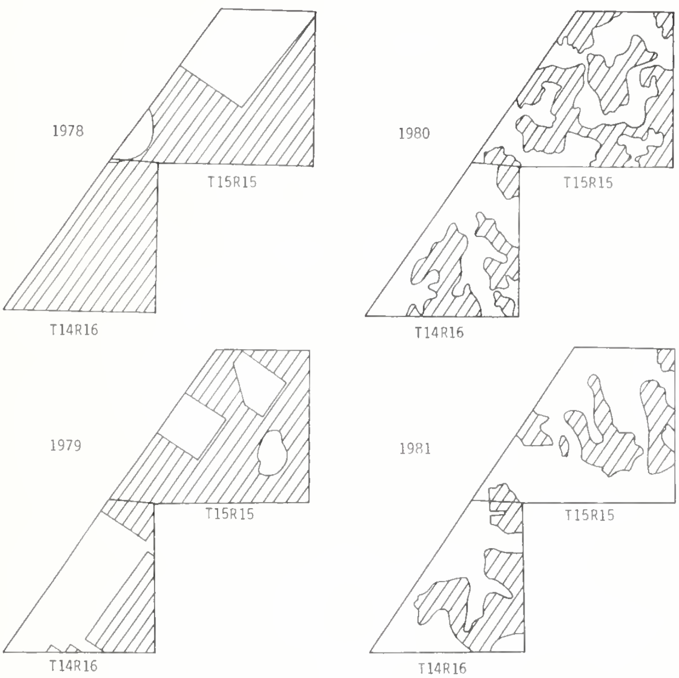

Figure 4. Spray acreage (in crosshatch) on the St. Pamphile Demonstration Area from 1978 to 1981. Sprayed acres were reduced from about 30 000 (12 140 ha) in 1978 to about 12 000 (4 856 ha) planned for 1981.

Targeting of spraying involves the precise treatment of small, irregular blocks in contrast to large, geometrically regular areas. Achieving this requires different insecticide delivery systems than prevailed in the late 1970's, when most acreage in Maine was sprayed from large, 4-engine aircraft. A trend toward use of small agricultural aircraft and helicopters in the last 2 to 3 years has come about partly because of the demand for more precise treatment of the most vulnerable stands and partly for more precise adherence to no-spray buffers around waterways and human settlements. This trend is a definite asset in furthering our goals. Improvements in electronic or visual systems of spray aircraft guidance are still needed. We are eager to incorporate these when we have the opportunity.

The targeting of spray application is considered a significant step toward integrated pest management of the spruce budworm for several reasons. A major one is that unsprayed stands can be interspersed among sprayed parcels on a small scale. Populations of the budworm's natural enemies, which assist in its control, may be preserved and perhaps increase in the unsprayed areas and spread into the sprayed zones. The untreated areas may also provide for reestablishment of other terrestrial and aquatic fauna impacted by chemical treatment.

Further reductions in insecticide use are possible through targeted harvesting, through they occur more gradually because only a small portion of the treatment area can be affected by harvesting in any one year. Wherever possible, we have tried to use the shelterwood system because it best meets a goal of discriminating heavily against fir in the first cut, conserves conifers, and hopefully allows for regeneration of more spruce before the residual overstory is removed. After most or all of the highly vulnerable fir is cut, residual stands should require less frequent or no further treatment with insecticides.

Maine's spruce-fir forest averages about half fir and half red spruce. Individual stands, however, vary widely from nearly pure fir to pure spruce, so usually a single, broad silvicultural prescription cannot be applied for even a small spray block. Before harvesting, foresters make intensive stand-analysis cruises to estimate stand composition and volumes. Cuts are then prescribed according to the following guidelines:

(1) Stands of nearly pure spruce are excluded from both harvesting and spraying. These tend to be of red-black spruce hybrid variety, and are surviving with no protection. Mortality of the minor fir component represents little or no loss in volume and decreases the already low vulnerability of the stand.
(2) In stands of mixed spruce-fir, a fir-only partial cut is made where there will be a sufficient residual volume of spruce and nonhost species to maintain a windfirm residual stand. Windfirmness has been and continues to be a serious problem on many soils and topographic sites.
(3) Stands with so much fir that complete fir-only removals would result in blowdown in the residual spruces are generally clearcut. However, we have also established trials of a variety of shelterwood approaches to manage these high fir stands, in which residual firs are left in strips (strip shelterwood), below a 20-cm (8-in) diameter limit, or are designated by marking. This procedure may allow fir-only harvests to be made in these stands, but protection may still be required until the second cut removes the remaining fir.

Roads and harvesting operations are planned so that the stands treated by one of the above procedures can be grouped into sizable blocks, which can then be eliminated from spraying. If stands that can be treated by partial cutting are accessible, they should be cut first. This way, more area is converted to a lower vulnerability more rapidly than by clearcutting, because more area must be harvested to produce the same volume.

Our approach to targeted spraying suggests that a substantial reduction in acreage sprayed can be made without sacrificing essential forest resource. This can be done quickly. Similar gains also seem possible through the targeted harvesting approach, but these gains will come more slowly, perhaps requiring decades. We expect that the ultimate benefits will be substantial, yielding a better balance of host age classes and a greater representation of spruce in the next rotation. Both of these should contribute to lower vulnerability to spruce budworm attack in the future.

Our evaluations of the effects of reduced insecticide application on the natural control complex, and possible augmentation of control, are incomplete because of the time lags involved. Several years will be needed to evaluate these phenomena because of the rise and subsequent decline of populations in the untreated areas as the host tree population dies.

Although we have mentioned only the principles involved in putting the approach in place, we have encountered a need to solve a broad range of forest management problems from stand analysis through harvesting technology. The definition of landowner objectives and goals has played and will continue to play an important role in the implementation of effective and appropriate integrated management systems.

D. Gordon Mott — USDA Forest Service, Orono, Maine
Robert S. Seymour — Green Woods Project, Orono, Maine
John D. Dimond — University of Maine, Orono, Maine

Working Group Meetings In The East

The next CANUSA-East Working Group meeting will be held in Quebec City, October 19-23, 1981. Further details about the meeting will be announced at a later date, but we would like to remind all U.S. cooperators that expenditures of CANUSA funds for foreign travel (including Canada) require prior approval from the Program Leader's office (W.O.). Requests for approval should be submitted early to Dan Schmitt, Program Manager, for referral to Washington.

Professional Meetings — Update

The list of meetings of professional societies and groups that appeared in *Newsletter* No. 15 (March 1981) was based on the best information available from the sponsoring organizations at press time. Since then, several changes have come to our attention, as shown below. *Newsletter* readers are requested to keep us informed of new dates and places for the groups listed.

Entomological Society of America
1981 — Eastern Branch, Syracuse, New York, Oct. 5-7.
1982 — North Central Branch, Sioux Falls, South Dakota, March 23-25.

Northeastern Forest Pest Council
1982 — Portland, Maine, Mar. 9-10.

Northeastern Forest Insect Work Conference
1982 — Portland, Maine, March 11.

Western Forest Insect Work Conference
1982 — Bozeman, Montana

Forest Pest Control Forum

The dates for the Forest Pest Control Forum for 1981 are now established. The meeting is scheduled for December 1-3, 1981, at the Conference Centre, Ottawa. For information, contact Grant Davidson, telephone 613-997-1357. Suggestions for agenda items would be welcome.

Technology Transfer Meeting

CANUSA-West's technology transfer working group met May 27 and 28 in Portland, Oregon. Participants spent the 2 days revising outlines for end-of-program documentation. Previously the members had developed five outlines for possible manuals covering the biology and ecology of the budworm, and information on the tree, stand, forest, and region. At the May meeting these were consolidated into three "books" to be published by CANUSA-West.

The three books will provide a comprehensive synthesis of Program findings with previously known information about the western spruce budworm. Two of the books will be guides for forest managers — for detecting and evaluating effects or potential effects of budworm in the forests being managed, for comparing available management strategies, and providing support for management decisions related to the budworm. The third book, detailing the biological basis for the management guides, will describe the host trees, the insect, and their complex interaction.

One management guide will focus on the effects of the insect on trees and stands, outlining operational methods for detection, evaluation, and control. The other will treat larger areas — forests and regions — where short- and long-term planning are the central concern.

All three books will describe both the usefulness and limitations of the systems of models developed through the Program to aid in making management decisions. The books will be cross-referenced so interested readers can associate discussions on making management decisions with the relevant biological information.

In addition to these documents, CANUSA-West plans on publishing some how-to's and brochures.

Working group members also suggested possible authors for the various chapters. Program management has selected only 15 people from those suggested so as to keep the number of authors to a manageable level.

Northeastern Forest Insect Work Conference

Mark Houseweart, University of Maine at Orono, recently sent us a copy of the proceedings of the fourteenth annual Northeastern Forest Insect Work Conference, held in Bangor last February. Included are brief summaries of the five workshops held at the latest (1981) conference. Subjects and moderators included hardwood insects (Mark Houseweart), tree genetics (Kathy Hale and Dave Struble), photography (Sue Goldman), environmental monitoring (Terry May, Kathy Gibbs, J. Stanley, Paul Adamus), and softwood insects (John Dimond). Contact Mark if you are interested in receiving a copy of the proceedings.

Also, in relation to this annual conference, word has come from Brent Teillon, Vermont Forest Resource Protection, that next spring both the Northeastern Pest Council Meeting (March 9-10, 1982) and the fifteenth annual Northeastern Forest Insect Work Conference (March 11, 1982) will be held in Portland, Maine. The intention, obviously, is to reduce travel expenses for those who regularly attend both annual sessions. Detailed meeting agendas will be mailed next winter, but Brent is soliciting ideas and suggestions now.

Spruce Budworm Workshop

Greentree Consultants, Inc. (Lansing, Michigan) recently conducted two workshops on cost-benefit approaches to forest pest management. Ultimately a manual will be developed primarily for the use of public agency foresters. The Greentree representatives also introduced at the workshops a product developed for a second CANUSA project, an investment analysis system for nonindustrial forest landowners with a budworm problem. The tightly programmed version of the Greentree basic model, intended for hand-calculator use, is a remarkably versatile tool for situation analysis by consultants, Cooperative Forest Management foresters, extension foresters, or even landowners having a modest familiarity with common forest mensuration terms. The hand-calculator version even has a tax package, requires minimum input, and at the option of the user outputs rate of return on investment or cost-benefit ratio for management options. As a result of workshop experience which indicates that greater user flexibility is desirable, Greentree is undertaking some reprogramming of the hand-calculator package. CANUSA-East expects to make the final version available by late spring 1982.

Toxic Chemicals Workshop

Through May 19-21, 1981, George Green (FPMI), together with Chuck Buckner from CFS Headquarters, represented the CFS at a Department of the Environment (DOE) Toxic Chemicals Management Program Workshop held in the magnificent Department of Transport Training Center in Cornwall, Ontario. The workshop, attended by approximately 50 participants from within and outside DOE, was designed to evaluate the problem area and contribute to establishment of concrete objectives for this DOE program.

Ohman Succeeds Roget

CANUSA's Joint Policy and Program Council (JPPC) welcomed a new member at its August 1981 meeting. John H. Ohman, new Deputy Chief for State and Private Forestry (S&PF) of the USDA Forest Service, succeeds retiring Einar L. Roget. Ohman will be in charge of all Forest Service cooperative programs with the state foresters and nonfederal forest landowners, including forest pest management and fire protection.

John Ohman has extensive experience in insect research. He has worked for the Forest Service since 1961 in various forest research positions, and was appointed Director of Forest Insect and Disease Research Staff in the Washington Office in 1978. This assignment led to Ohman's becoming Associate Deputy Chief for Research and then Associate Deputy Chief for S&PF.

In announcing Ohman's promotion, Forest Service Chief Max Peterson said his "experience in forestry research will contribute to our success in transferring this knowledge to state and private forest landowners and wood industry operators." Clearly, Ohman's particular talents will benefit the JPPC as it decides how the CANUSA Program will handle technology transfer during its last 2 years.

Environmental Health Monitoring Reports

Environmental Health Monitoring Reports for the 1979 and 1980 Maine Cooperative Spruce Budworm Suppression Project have been prepared by the Maine Forest Service. The 1979 document reports the results of four studies to examine the impacts of insecticides on aquatic insects, two studies of impacts on bird populations, and one looking at effects on fish. Two additional studies examined airborne drift — useful data in planning spray buffer zones.

The 1980 report contains data from monitoring airborne carbaryl levels at four locations during the 1980 spray program. The purpose of the study was to evaluate carbaryl exposure to residents in populated regions adjacent to the spray areas. Low levels of carbaryl were found in the air many miles from the actual spray blocks and, in some cases, several days after the spray operation. But it was calculated that "residents of adjacent populated areas have a potential of 0.67 micrograms per day, . . . approximately 1/1000 of the allowable daily intake of carbaryl . . . and approximately equal to the

average amount of carbaryl digested daily by Americans."

For further information, please contact

Maine Forest Service
Department of Conservation
State House Station #22
Augusta, ME 04333
Telephone: (207) 289-2791

New Insecticide Impact Data

Are you interested in learning more about the impacts of insecticides used to control forest pests? If so, you might read a recent report entitled "Seasonal Data on the Microbial Community of Four New Brunswick Ponds, Including a Period of Experimental Spraying with Matacil®" by J.K. Elner and D.J. Wildish (Can. Tech. Rep. Fish. Aquat. Ser. 933. 21p.)

These CANUSA researchers have been studying the aquatic microbiological communities in four freshwater ponds, three of them deliberately sprayed with Matacil® (aminocarb). Treatment rates were 140, 280, and 700 g/ha. The fourth pond, unsprayed, was used as a control.

The report presents data on the microbiological cycle of these ponds from September 1979 to September 1980. Even at the highest treatment rate (700 g), Matacil® had no apparent effect on pond microbiology. All the ponds exhibited the unusual phenomenon of a winter maximum in algal numbers during a period of ice cover, and a normal spring bloom. For further information, contact the authors at Department of Fisheries and Oceans Biological Station, St. Andrews, New Brunswick, R0G 2X0.

Aerial Trials Cancelled

Planned small-scale aerial trials with Dimilin® and several benzoyl-urea moult inhibitors aainst the spruce budworm, white pine weevil, and the oak leaf shredder have had to be cancelled by FPMI this year. Research permits were denied by Agriculture Canada based on concerns expressed by National Health and Welfare. The concern is centered around establishment of a no-effect level for these materials. Hopefully, this problem can be resolved by next field season to allow continuing development of these promising compounds.

Entomopathogenic Fungi Of The Spruce Budworm In Newfoundland — 1980

The potential use of entomopathogenic fungi as a biological control agent or microbial insecticide against the spruce budworm is being investigated in Newfoundland.

In 1980 during a survey of the natural enemies of the spruce budworm in Newfoundland, five species of entomopathogenic fungi were recovered:

Paecilomyces farinosus (Holm ex. S.F. Grey) Brown and Smith — Cadavers are covered with a thick mass of chalky white conidia. This fungus has been recorded on a wide range of insects. It has been used on experimental control work on the gypsy moth, pine shoot tip moth and other insects in the United States and Europe. It has not been recorded previously on the spruce budworm and this represents a new host record.

Hirsutella gigantea Petch — Cadavers are easily recognized by the many outgrowths of the synemmata. The conidia are oval. This fungus has been reported on spruce budworm found in Ontario. A related species, *Hirsutella thompsonii*, is used against the citrus red mite in Florida and a mass production method with submerged culture technology has been developed. This is the first time that *H. gigantea* has been reported in Newfoundland.

Entomophthora sphaerosperma Fresenius — The conidia are usually whitish and fusiform in shape and were found to be patchy on cadavers. This fungus had been reported previously on the spruce budworm in Newfoundland, Ontario, and Maine. The conidial stage of this fungus has been tested in small-scale field trials against the spruce budworm in Maine.

Entomophthora egressa MacLeod and Tyrrell — Larval cadavers are usually fully covered with yellowish brown conidia. On the pupal host-stage, conidia are usually found at the intersegmental membrane of the abdomen. The conidia are pyriform (pear-shaped) and with a single nucleus. This fungus has been reported on the spruce budworm in Newfoundland, Ontario, and Maine. Dr. D. Tyrrell, at the Forest Pest Management Institute at Sault Ste. Marie, is investigating a method of mass producing the thick-walled resting spores.

Conidiobolus sp. — Symptoms of the mycosis are similar to those caused by *E. egressa*. The conidia are pyriform with multinuclei. This fungus was first reported in 1978 on the spruce budworm in Maine. This species has not been reported previously in Newfoundland.

Experts do not agree on the taxonomy of the above three entomophthoralean fungi. This fungal group is now under revision by Dr. R.A. Humber, an insect mycologist at the Boyce Thompson Institute, Ithaca, N.Y.

The unique climatic conditions, high humidity, and short hours of sunshine in Newfoundland may favor the development of fungal disease of forest insects. More field and laboratory research will be directed toward the use of these entomopathogenic fungi as a component in the integrated pest management program.

University Of Toronto Biology Class Of '51 Reunites

The University of Toronto Class 5T1 were reunited on their thirtieth anniversary in the rural setting of the farm of Tove and John Findlay near Woodstock, Ontario.

Several budworm notables were included in the gathering: Chuck Buckner (Program Leader, Canada); George Green (Director, Forest Pest Management Institute, Sault Ste. Marie); Ken Watt, renowned author and early budworm modelling specialist; Dalton Muir, biologist and natural history photographer; Doug Roseborough (Director of Game, Ontario Ministry of Natural Resources); Ken Griffiths, scientist at the Great Lakes Forest Research Centre; and Harold Welch (former Chairman of Zoology, University of Manitoba). Careers of all these prominent biologists have impacted on budworm research at various times and places over the past 30 years.

In The Family

Everybody loves a winner. So, this month we salute Jackie Robertson, spruce budworm investigator and recipient of the U.S. Department of Agriculture's second highest honor — the Superior Service Award. Though most of Jackie's work is funded through the Pacific Southwest Forest and Range Experiment Station (Berkeley, Calif.), the CANUSA Program is only too willing to bask in her reflected glory.

Jackie received the award for her efforts to improve the statistical procedures used in evaluating the potential effectiveness of candidate insecticides. She was also commended for revising laboratory procedures so that bioassays — tests in which candidate insecticides are applied to insect pests — now more closely simulate forest conditions.

Jackie has worked with the Insecticide Evaluation Project since her undergraduate days at the University of California at Berkeley and has served as research entomologist since 1971. She is author or coauthor of more than 50 scientific and technical articles, including several on her spruce budworm research in the West.

In the past, the Department has recognized Jackie's contributions with a Certificate of Appreciation, a Certificate of Merit, and a Quality Step Increase (financial award). She also served as the Forest Service's representative to a USDA-sponsored forum on the International Women's Year in 1975.

Jackie would be the first to point out that she's at best a distant cousin, but we're proud to have her in the CANUSA family.

Personnel

FPMI's Pesticide Chemistry Unit suffered a severe blow last spring when two staff members, Sunny Szeto and Ralph Hindle, were the successful candidates for two positions with Agriculture Canada in Vancouver and Calgary, respectively. Sunny Szeto left to assume his new duties in early May, and Ralph Hindle left in late June.

The MFRC Research Scientist position for the Budworm Modelling Group Leader has been filled by Dr. Wilfred R. Cuff. Dr. Cuff is presently working for Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia. He is expected to arrive in Fredericton in early fall.

FY 81 Studies Funded By CANUSA-U.S.-East

Evaluation of eastern spruce budworm pheromone as a survey tool.
D.C. Allen and L.P. Abrahamson,
SUNY College of Environmental Science and Forestry,
Syracuse, N.Y.

Pheromone chemistry and development of pheromone sampling systems for eastern spruce budworm.
Dr. R.T. Cardé,
Michigan State University,
East Lansing, Mich.

Cost efficient wood salvage strategies for budworm infected timberlands — A computer based system.
T.J. Corcoran,
University of Maine, School of Forest Resources,
Orono, Me.

Microclimatic and phenological differences on balsam fir, white and red spruces in relation to the development and epidemiology of the spruce budworm.
Dr. Y. Hardy,
Laval University, Faculty of Forestry and Geodesy,
Quebec, Que.

The site and stand factors predisposing balsam fir in Maine to attack by the spruce budworm.
H.J. Heikkenen,
American Institute of Dendrochronology, Inc.,
Virginia Polytechnic Institute and State University,
Blacksburg, Va.

Efficient aerial sprays — Analytical systems for mass and droplet transport.
C.M. Himel,
University of Georgia,
Athens, Ga.

Analysis of air levels of the spruce budworm pheromone by a rapid and sensitive bioluminescent assay.
Dr. E.A. Meighen,
McGill University, Department of Biochemistry,
Montreal, Que.

Integrated management of spruce budworm.
C. Shoemaker,
Cornell University, Department of Environmental Engineering,
Ithaca, N.Y.

Improvement of spruce budworm population sampling for low and moderate population levels.
G.A. Simmons,
Michigan State University, Department of Entomology,
East Lansing, Mich.

Zoophthora radicans as a mycoinsecticide for spruce budworm control.
R.S. Soper,
Boyce Thompson Institute, Insect Pathology Res. Center,
Ithaca, N.Y.

Techniques for forest damage assessment — spruce budworm.
Dr. J.A. Witter,
University of Michigan,
Ann Arbor, Mich.

Field cage validation of a male annihilation strategy for spruce budworm control.
Dr. C.J. Wiesner,
New Brunswick Research and Productivity Council,
Fredericton, N.B.

In situ size-frequency analysis of forest spray using a PMS Ruby-Laser system.
W.E. Yates, N.B. Akesson, and J. Barry,
University of California, Engineering Department,
Davis, Calif.

Effects of aspen-balsam cutting methods on damage by the spruce budworm in northern Wisconsin.
H.O. Batzer and J.W. Benzie,
North Central Forest Experiment Station,
USDA Forest Service,
St. Paul, Minn.

Nutritional values of balsam fir, white spruce, and red spruce foliage related to eastern spruce budworm infestations and site conditions.
Dr. M.M. Czapowskyj,
Northeastern Forest Experiment Station,
USDA Forest Service,
Orono, Me.

Developing *Trichogramma* as a potential suppression strategy.
Dr. D. Jennings and M. Houseweart,
Northeastern Forest Experiment Station,
USDA Forest Service,
Orono, Me.

Development of an Enzyme-Linked Immunosorbent Assay (ELISA) for *Bacillus thuringiensis* used in the control of spruce budworm.
B.D. Hammock,
University of California,
Berkeley, Calif.

Genetic variation of spruce budworm populations.
N. Lorimer,
North Central Forest Experiment Station,
USDA Forest Service,
St. Paul, Minn.

Analysis of variation in foliar chemistry of balsam fir and its relationship to behavior, survival, and growth of spruce budworm.
W.J. Mattson, Jr.,
North Central Forest Experiment Station,
USDA Forest Service,
St. Paul, Minn.

Effect of minor variations in temperature, vapor pressure deficit, and population density on quality factors and survival of eastern spruce budworm.
W.E. Miller,
North Central Forest Experiment Station,
USDA Forest Service,
St. Paul, Minn.

Host plant nitrogen utilization by spruce budworm.
M.E. Montgomery,
Northeastern Forest Experiment Station,
USDA Forest Service,
Hamden, Conn.

Determination of the potency of selected B.t. strains against *C. fumiferana* (Clem).
N. DuBois,
Northeastern Forest Experiment Station,
USDA Forest Service,
Hamden, Conn.

Effect of spray delivery systems on the potency of B.t. tank mixes against *C. fumiferana*.
N. Dubois,
Northeastern Forest Experiment Station,
USDA Forest Service,
Hamden, Conn.

Plant composition and production following fire and clearcutting for salvage in budworm-defoliated stands.
H. Crawford,
Northeastern Forest Experiment Station,
USDA Forest Service,
Orono, Me.

A bole-volume growth model for spruce-fir stands.
D. Solomon,
Northeastern Forest Experiment Station,
USDA Forest Service,
Orono, Me.

The shigometer and SBW hazard index.
A. Shigo,
Northeastern Forest Experiment Station,
USDA Forest Service,
Orono, Me.

Alternate hosts for *Trichogramma*.
Dr. D. Jennings,
Northeastern Forest Experiment Station,
USDA Forest Service,
Orono, Me.

The production of wood in balsam fir and spruce stands as influenced by varying degrees of SBW attack.
D. Solomon, G. Hughes, and R. Gregory,
Northeastern Forest Experiment Station,
USDA Forest Service,
Orono, Me.

The integration of targeted harvesting of balsam fir with precision chemical protection.
J. Dimond,
University of Maine,
Orono, Me.

Silvicultural practices to minimize spruce budworm impact in Maine and Canada.
S. Goldman,
International Paper Company,
Bangor, Me.

Presalvaging high-risk balsam fir stands.
R. Ford,
Northeastern Area, State & Private Forestry,
USDA Forest Service,
St. Paul, Minn.

Spruce budworm technology transfer in the Lake States region with build-in feedback for update and refinement.
J. Witter and C. Olson,
University of Michigan,
Ann Arbor, Mich.
G. Simmons,
Michigan State University.
East Lansing, Mich.

Reevaluation of 1980 B.t. sprayed plots to detect SBW population change.
J. Dimond, University of Maine, Orono, Me.
S. Swire, University of New Hampshire, Durham, NH
Pat Shea, Pacific Southwest Station, USDA Forest Service, Davis, Calif.
Frank Lewis, Northeastern Forest Experiment Station, USDA Forest Service, Orono, Me.
Don Renlund, Wisconsin Department of Natural Resources, Madison, Wisc.

Item From The Press

Spruce worm spreads — Since its first appearance in Ontario near Lake Huron in 1967, the spruce budworm has munched its way to the Quebec border and north to James Bay.

Natural resources official Rod Carrow says the "outbreak is expanding and intensifying each year and there is no sign of it letting up."

Since the balsam fir — the budworm's favorite — is not as common or economically important here as it is in the Maritimes, the province decided to let nature run its course for the time being, Carrow says.

The only areas where chemicals are now used to fight off the infestation is in forests the ministry uses for seed production and one small area near Kirkland Lake where balsams represent 40 per cent of the forest.

All told 25,000 acres of forest are sprayed with the insecticide Matacil, which Carrow says has yet to be associated with human health hazards. The highly controbersial chemical fenitrothion, which has been linked to cancer and birth defects, is widely used to control the infestation in the Maritimes.

Ontario could find itself in very serious problems at the end of the decade, however, as it is feared the budworm will turn on the white and black spruce trees once its had its fill of balsam, Carrow says. Spruce trees support the province's entire pulp and paper industry.

(Ottawa Citizen — June 12, 1981)
Ottawa, Ontario

Recent Publications

From Forest Pest Management, State and Private Forestry, Southwestern Region, USDA Forest Service, 517 Gold Avenue S.W., Albuquerque, NM 87102, these two reports are available:

"Western spruce budworm suppression and evaluation project using carbaryl — 1980." Report R-3 81-9 by I.R. Ragenovich and D.L. Parker.

"Western spruce budworm assessment project — 1980." Report R-3 81-7 by C.R. Stein.

Also these two reports are available from USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 W. Prospect Street, Ft. Collins, CO 80526:

"Remote sensing of wildland resource: A state-of-the-art review." Gen. Tech. Rep. RM-71 by R.C. Aldrich.

"Key to large lepidopterous larvae on new foliage of Douglas-fir and tree firs." Res. Note RM-401 by W.M. Carolin and R.E. Stevens.

Several reports are available from the Forest Pest Management Institute, P.O. Box 490, Sault Ste. Marie, Ontario P6A 5M7. They are:

"Aquatic impact studies of a spruce budworm control program in the Lower St. Lawrence Region of Quebec in 1978." Report FPM-X-26 by S.B. Holmes.

"Environmental impact assessment of a semi-operational Permethrin application." Report FPM-X-30 by P.D. Kingsbury and D.P. Kreutzweiser.

"Persistence of microsporidia in populations of the spruce budworm and forest tent caterpillar." Report FPM-X-39 by G.G. Wilson.

"Fenitrothion and forest avifauna studies on the effects of high dosage applications." Report FPM-X-43 by P.D. Kingsbury and B.B. McLeod.

Two reports are available from the Newfoundland Forest Research Centre, P.O. Box 6028, St. John's, Nfld A1C 5X8.

"Effects of aerial application of Matacil® on larval and pupal parasites of the eastern spruce budworm, *Choristoneura fumiferana* (lepidoptera: Tortricidae)." Report N-X-189 by Imre S. Otvos and Arthur G. Raske.

"The status of the spruce budworm in Newfoundland in 1979." Report N-X-190 by B.H. Moody.

Other reports of interest are:

B. Payandeh. 1979. "Stand projection models for northwestern Ontario's forest types." Report 0-X-298. 12p. Great Lakes Forest Research Centre, P.O. Box 490, Sault Ste. Marie, Ontario P6A 5M7.

N.W. Gosling. 1981. "Understanding the spruce budworm in Michigan," Nat'l Woodlands, March-April. p.8-10.

J.A. Witter. 1981. "Techniques for assessing the impact of the spruce budworm in Michigan." XVII I.U.F.R.O. World Cong. Proc., Kyoto, Japan. Sept. 6-17, 1981.

J.A. Witter and J.P. Mog. 1981. "An integrated approach for assessing spruce budworm damage and developing a hazard-rating system and stand models for spruce-fir stands in Michigan's Upper Peninsula." *In* R.L. Hedden, S.J. Barras, and J.E. Coster, Tech. Coords. Hazard-rating systems in forest insect pest management: symposium proceedings. USDA Forest Service, Gen. Tech. Rep. WO-27.